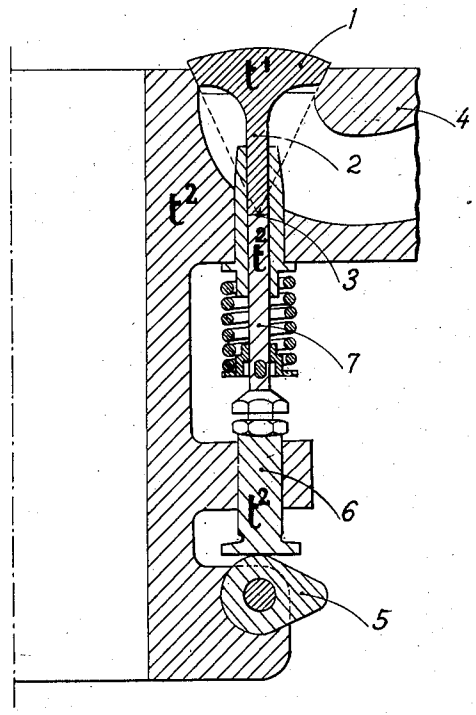
Jan. 8, 1935. L. SAIVES 1,987,160

VALVE OF EXPLOSION MOTORS OR INTERNAL COMBUSTION ENGINES

Filed Nov. 20, 1930

Fig. 1.



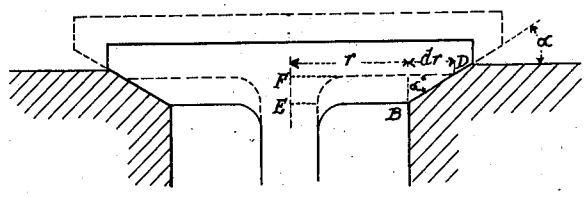


Fig. 2

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Patented Jan. 8, 1935 1,987,160

UNITED STATES PATENT OFFICE

1,987,160

VALVE OF EXPLOSION MOTORS OR INTERNAL COMBUSTION ENGINES

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Application November 20, 1930, Serial No. 497,022
In France December 11, 1920

2 Claims. (Cl. 123—188)

This invention relates to means whereby distribution of explosion motors and internal combustion engines provided with valves may be rendered perfectly silent and smooth working by completely compensating for the relative expansions by heat of the cylinder, cylinder passages, cam-shaft, and thrust rods or tappets, and thus allowing of the engine running with an adjustment having unchangeable clearance; it further provides for constructing cams opening and closing very smoothly, whilst still keeping the points of opening and closing fixed.

The difficulty to be met, which is especially great in the case of the exhaust valves of such engines, resides in the fact that the temperature of each of the parts of an engine does not depend upon a single variable accordingly as the engine is cold, warm or hot, but upon several variables. All the members do not heat up with the same rapidity and the valve heads and the bases of their spindles for example are more sensitive to the condition of the engine than to its general temperature. By taking into account a second variable, which for example will be the temperature of the head of the exhaust valves the thermal state of the engine is defined in a very satisfactory way.

The means which, according to the invention, leads to the industrial result sought, consists in determining the angle of the cone of contact of the valve and of its seat by the conditions and methods, which will be explained. These means may be supplemented if necessary by the addition of pieces of metal more or less expansible by heat which are interposed in the control or constitute part of the usual members, such as valve spindle, thrust rod and the like.

As stated above since the temperatures of the several members of the engine and especially of the members of the valve mechanism cannot be suitably determined except by making use of at least two independent variables, any exact compensation must take into account these two variables, which for example will be:

On the one hand the slow changes in the temperature of the aggregate which comprises the water or air circulation, the thrust rods and valve spindles;

On the other hand, the quick changes in the temperature of the disc of the valve head.

When the valve gets hot, its head expands and as it is conical and placed upon a conical seat which heats differently and less quickly, it rises carrying with it the whole valve and partially compensating for the expansion of the top of the spindle.

Experience shows that in engines as now constructed this rising of the valve head is far from being sufficient to compensate for the elongation of the spindles of the exhaust valves; in the case of the admission valves it is usually either too much or too little.

According to the invention the angle of the cone of contact between the valve and its seat is increased from that customary in the case of the exhaust valves so as to increase the rise of the valve head in its seat under the action of the expansions. In the case of the admission valves it is increased or decreased, according to circumstances and in either case said angle is deduced from the measurements and calculations as hereinafter specified.

Experiments carried out with different angles have shown that instead of making with the wall of the explosion chamber an angle of 0° (flat valves) 30° or 45° corresponding to the shapes customarily used the seat of the side exhaust valves ought to make a much larger angle, which may exceed 60°, whilst always remaining below the angles at which there is risk of jamming, which approximate to 80°.

Up to the present time in determining these angles attention had only been paid to the outflow of the gases with the valve lifted and to the valve seat. A compromise had been adopted between the flat valve favourable to the passage of the gases and the valve at 45° which ensures better centering.

According to the invention for fixed values of the diameters of the valves, and the large angles of approximately 65° to 70° above-mentioned relate to the exhaust valves, for which the issue of the gases is not a question of overwhelming importance.

The calculation hereinafter described of the angle for each kind of valve is based upon at least two series of precise measures of the relative expansions taken upon the engine when running under varying conditions of temperature, and of temporary or continuous running, each series of measures being taken with a different seat angle.

In the first place observation is made of the changes in clearance in the valve stem, for example between the case of the completely cold engine, and that of the cold engine with hot valves during the first minutes of starting under full load. This change is not the same in two series of measures taken with two different angles and

the difference is proportional to the difference of the tangents of the two angles. Thence is deduced the tangent of the angle and consequently the angle, which should not give any change, as will hereinafter be explained.

Observations are then made of the changes of clearance for example between the cold and the hot engine, upon which the angle acts in proportion to its tangent, without always giving a perfect compensation.

In general it has been assumed that the entire mass of the engine and the crank case is nearly at the same temperature and expands in the same degree; this assumption is not always quite accurate and therefore it may be necessary to complete the arrangement by the addition of the insert of one or more pieces of more or less expansible metal, which, for example, is or are interposed in the clearance space in the valve stem or which replace control members and the sizes of which are easy to determine by trials and calculations.

Such insertions are necessary when the distribution casing is of a light metal which does not expand the same as the other parts of the engine or when the operating means comprise rocking levers which do not expand in the same way.

The placing of inserts is of course necessary when the members involved in the engine case and valve system are of metals having the same co-efficient of expanson, like cast iron and the majority of steels which heat equally and simultaneously.

The accompanying two figures of drawing will explain the operation of the arrangement in this case in particular, in which

Figure 1 is a sectional view showing a portion of an internal combustion engine case, valve, and valve operating mechanism, and

Figure 2 is a detail of a valve head illustrating its expansion on a large scale on which the calculations are based.

In the first place it must be assumed that the head 1 of the valve and the top 2 of the stem up to the geometrical apex of the cone are at an identical variable temperature t^1: that the cylinder and the casings 4, the cam 5, the thrust rods or rocking levers together with the adjusting members, rods and tappets 6 and the stem 7 of the valve, all having the same co-efficient of expansion, are at an identical variable temperature t^2.

It is understood that if each of these two aggregates at independent temperatures t^1 and t^2 remaining constant, the cone of the seat and the cone of the valve keep their angle and continue coincident because the diameter of the valve will vary in proportion to compensate for the lift of the valve off its seat due to expansion in the length of the valve stem, that their geometrical apices are also coincident, and that no change of clearance or jamming is caused, whatever may be the two independent variables t^1 and t^2.

The head of the valve is the part which is subjected to the highest temperature (t^1) whilst the top of the valve-rod is at a lower temperature, and the bottom of this rod at a still lower one (t^2).

Under the action of these temperatures which are distributed gradually along the valve and its rod, the valve is of a different length from that which it would have if it were throughout at the temperature t^2. Its elongation has a certain value and it is easy to calculate the length of a bar of the same metal which if heated from the temperature t^2 to the temperature t^1 would give the same elongation as the valve. This length of the bar is evidently less than the length of the valve since the latter is as a whole at a temperature below t^1; let 3 in the figure be the point on the valve-rod which is at a distance equal to the length of this bar below the level of the valve-seat. It follows from the above definition of the point 3 that the elongation of the valve is the same as if it were at the temperature t^1 from the head to the point 3 and at the temperature t^2 below the point 3. It is clear that for all temperatures t^1, t^2 the distribution of temperature from the top to the bottom of the valve takes place similarly and that, all the elongations of the valve being equal, the so-called mean point 3 will remain in the same place.

The invention consists in taking, as apex of the cone formed by the head of the valve and by its seat, the mean point 3; if this is done as shown in the accompanying drawing, the respective expansions will be compensated.

Obviously points 3 do not really exist at which the temperature of the valve changes suddenly from one value t^1 to another value t^2, but it is understood that there is a middle point such that, with respect to t^1 and t^2, the insufficiency of temperature on one side compensates for the excess of temperature on the other. The expansion of the part of the spindle where the progressive change of temperature takes place is assumed the same as if there were a clear division in the distribution of the temperatures, as indicated at the point 3, the difference in hatching of the movable valve member above and below the point 3 being for the purpose of representing the two temperatures t^1 and t^2 of the parts. Valve stem 7 is necessarily an integral stem and not broken at the point 3 and it is obvious that for such calculations as herein set forth the valve stem and head are of the same material and have the same coefficient of expansion.

It is only necessary to take this middle point as apex of the cone.

The difference in clearance in the case of an entirely cold motor, and in the case of a cold motor with hot valves, is a linear function of the tangent of the angle, there being one value of this tangent for which the change of clearance is null.

For a better understanding, reference is made to Figure 2 of the drawing wherein the cold valve was shown in continuous lines, and the hot valve in interrupted lines; α is the angle of the valve seat; E B is the radius r of the valve plate when said valve is cold. When the valve is hot, its radius increases and becomes $F\ D=r+dr$; this increase has for result a lifting of the valve of the height

$$E\ F=B\ C=C\ D \tan \alpha=dr \tan \alpha$$

However, at the same time, the increase of valve temperature has for effect an increase A of the rod below the point E. It results that the difference between the clearance in the case of a cold valve and the clearance in the case of a hot valve is $H=A-dr \tan \alpha$, whatever is the angle α. An experiment was made with an angle $\alpha_1=30°$ (which corresponds to an angle of 120° at the top of the cone constituting the valve seat) and a second experiment was made with an angle $\alpha_2=67°\ 30'$ (which corresponds to an angle of 45° at the top of the cone constituting the valve seat).

In the first case (angle α_1), it was found that the difference of clearance was $H_1=0.22\ mm.$; in the second case (angle α_2), it was found that the difference of clearance was only $H_2=0.065\ mm.$

For, having $H=0$, it is necessary to choose another angle α such that $A-dr \tan \alpha=0$.

For the three equations

$$A - dr \tan 30° = 0,22.$$
$$A - dr \tan 67° 30' = 0,065.$$
$$A - dr \tan \alpha = 0.$$

It is easy to determine α after having eliminated A and dr. It can thus be found that α must be 63° 20'.

In practice the diameter of the valve head is given preliminarily and depends upon the type of the engine because the constructor knows that, for a given engine, it is necessary to choose a valve head having a determined diameter in order to ensure a suitable passage-way for a satisfactory flow of gas when the valve is open. On the other hand, it is to be noted that the point 3 is on the stem substantially below the head and that, for this reason, the angle of the valve seat varies rather little when the head diameter is comprised between usual limits with respect to the stem length. Practically, whatever is the head diameter, said angle is more open than in known valves.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In an internal combustion motor, the combination with the motor casing of a valve and its stem each having cooperating conical seating surfaces wherein the surfaces are generated from a cone the apex of which is located centrally of the stem and determined by the point of difference in expansion of the valve head with the portion of the stem adjacent thereto and the lower portion of said stem.

2. In an internal combustion motor the combination with the motor casing and valve operating mechanism of a valve and its stem cooperating therewith, said casing and valve head having cooperating conical seating surfaces generated by a cone of such dimensions as to compensate for the difference in expansion of the valve and stem member and the casing and valve operating mechanism so as to permit the proper seating of the valve on the casing seat at all temperatures of the motor with substantially the elimination of clearance between the valve stem and valve operating mechanism, such generating cone having its apex located centrally of the stem and determined by the point of difference in expansion of the valve head with the portion of the stem adjacent thereto, and the lower portion of said stem.

LEON SAIVES.